Attorney Docket No.: F069

Amendments to the Specification

[1038] FIG. 4 shows a TTL detection system for an ion column 410 in which low energy secondary electrons from the sample, having energies of about 5 eV (electron volts), are accelerated up through the lens 412 by positive potentials on the elements of lens 412, the deflector plates 432 and magnetic deflector 414. The TTL system in FIG. 4 utilizes a magnetic deflector 414 to deflect the secondary electrons 418 off to the side while allowing the high mass-to-charge ratio primary ions 420 to pass nearly straight through column 410. Alternatively, a ~~Wein~~ Wien filter or an electrostatic deflection device could be used. An electron detector 424, such as a scintillator, continuous dynode multiplier, or channel plate, is then placed to the side for collecting and amplifying the electron signal for processing by standard FIB video electronics.

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[1040] ~~FIG. 6 is an electron optics computer simulation of the secondary electrons traveling from the sample back through the lens shown in FIG. 4.~~ The approximately 5 eV secondary electrons are accelerated rapidly by the lens element 440, which is at high positive potential, such as about 20,000 Volts. These electrons are decelerated as they pass through the lens element 430 and the deflection electrodes 432, but the secondary electrons still maintain trajectories that remain relatively close to the column axis. Magnetic deflector 414 or other separation device then directs the electrons toward the detector 424. FIG. 6 is an electron optics computer simulation of the secondary electrons 610 traveling from a sample 612 back through optical elements 616, 618, 620, and 622, with element 616 having a potential relative to sample 612.

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[1043] For thin film head trimming or other applications, the ion beams must be tilted about +/-3 degrees with respect to the normal to the sample surface. This beam tilting is to achieve undercutting or to yield cuts to the sides of the head with walls more normal to the head surface. This +/- 3 degree tilt can be achieved, for example, by tilting every other row of columns by about +/- 3 degrees with respect to the normal to the sample surface. In other words, in a multi-chamber system, the ion guns in one chamber can be tilted at an angle of about 3 degrees from a normal to the sample surface and the ion guns in the next chamber are tilted at an angle of about three degrees from a normal to the sample surface in an opposite direction.

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Replace the Abstract with the following paragraph:

ABSTRACT

A multi-gun FIB system for nanofabrication provides increased throughput at reduced cost while maintaining resolution. Multiple guns are maintained in modular gun chambers that can be vacuum isolated from the primary vacuum chamber containing the targets. A system can include multiple gun chambers, each of which can include multiple guns, with each gun chamber being capable of being vacuum isolated, so that each gun chamber can be removed and replaced without disturbing the vacuum in other gun chambers or in the main chamber. An optical column is associated with each gun. Optical elements for multiple columns can be formed in a bar that extends into several columns. Some of the optical elements are positioned in the gun chambers and others are positioned in the primary vacuum chamber. A through-the-lens secondary particle collection can be used in connection with each of the individual columns.

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